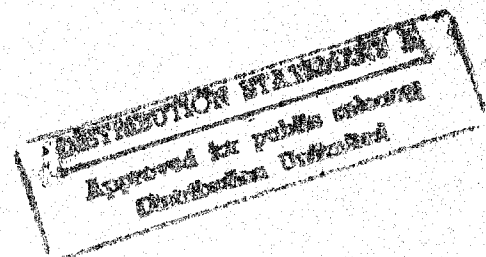
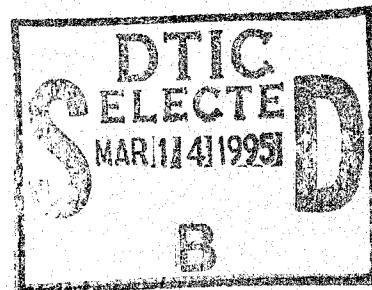

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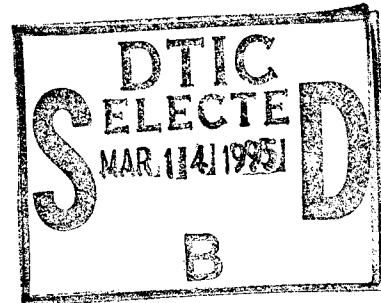


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JASON Final Report



January 1995

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1 JASON Topics 1994

During the 1994 JASON Summer Study twenty-five study topics were undertaken for the following agencies:

- Advanced Research Projects Agency (ARPA)
- The U.S. Army
- The Central Intelligence Agency (CIA)
- The Department of Energy (DOE)
- The Federal Bureau of Investigation (FBI)
- The U.S. Navy

Of these studies, twenty-one are included in this report. For each topic the report title, lead author, sponsor and report number are given. For those studies that can be described in unclassified terms a short abstract is included.

1.1 Advanced Computing

- **Study Leader:** Bob Westervelt
- **Study Sponsor:** ARPA
- **Report:** JSR-94-130 (U)

JASON undertook to examine technical issues associated with the design and construction of advanced computers on a twenty year time frame. Current CMOS technology was not covered, because it has been examined in detail by other groups. The study focused on two topics: superconducting and "single electron" logic, and advanced architectures.

1.2 ARM

- **Study Leader:** Henry Abarbanel
- **Study Sponsor:** DOE
- **Report:** JSR-94-300 (U)

The Atmospheric Radiation Measurement (ARM) Program is a DOE program that aims to collect extensive data from a small number of instrumented sites. The objective is to gain a better understanding of the chemistry and physics of atmospheric radiation transfer. JASON continued its involvement in this program by reviewing the current status and plans for the program.

1.3 Biomedical Imaging

- **Study Leader:** Mike Cornwall, Dave Nelson
- **Study Sponsor:** ARPA
- **Report:** JSR-94-120 (U), JSR-94-121 (U)

The ARPA Advanced Biomedical Technology Program has as one of its primary purposes the improvement of medical care on the battlefield, where most fatalities occur in the first hour after injury if adequate care is not provided. This year the emphasis of the JASON study in this area were improvements in magnetic resonance imaging (MRI) and in ultrasound. In MRI the desire is to make the required hardware smaller and useful in a wider variety of settings than is now common. One way to achieve smaller size is to reduce the B - field. Technologies that could lead to reduced B -fields are the use of highly polarized gases and high T_c receive coils. In Ultrasound, the desire is for both smaller and more capable instruments. In this study the use of modern signal processing techniques and the development of high-speed two-dimensional ultrasound arrays were examined.

1.4 Counter Proliferation

- **Study Leader:** Nate Lewis, Will Happer
- **Study Sponsor:** ARPA
- **Report:** JSR-94-140 (U), JSR-94-141 (U)

JASON reviewed major aspects of the DoD initiated counter proliferation program. The major components of this program are (1) warning of chemical and biological warfare attacks, (2) defense against chemical and biological warfare on the battlefield and (3) detection, characterization and defeat of underground structures.

In the area of warning there are two situations of interest a) pre-use warning of the manufacture and storage of CBW agents, and b) detection and warning of use of CBW agents on the battlefield. It was the conclusion of the study that there were very limited prospects for success in scenario (a) using LIDAR and air-sampling aircraft as have been proposed. The situation for scenario (b) is quite different. Given a cue of an artillery burst or other potential delivery means it should be possible to detect and identify known CW agents in the resultant smoke or aerosol cloud with remote sensors. Quatitative detection of BW agents by remote sensing is unlikely, given the low concentrations and the high natural background of pollens and other organic materials. The study recommended that a layered strategy, involving diverse detection schemes, should be developed for battlefield detection.

1.5 Covert Communication

- **Study Leader:** Bill Press
- **Study Sponsor:** Agency
- **Report:** JSR-94-540 (S)

This study does not lend itself to an unclassified abstract.

1.6 Electromagnetic Launchers

- **Study Leader:** Jonathan Katz
- **Study Sponsor:** ARMY
- **Report:** JSR-94-600 (U)

JASON examined the question of whether electromagnetic launchers should replace chemical guns as the main armament of the main battle tank. This question arises because of developments in three technology areas. The first technology is that of rotating pulsed power machinery. It is now possible to store sufficient energy to accelerate a large caliber kinetic energy penetrator, and to extract this energy fast enough to couple it to the projectile in a gun of practical length. The second technology is the development of more efficient rail guns, which, by reducing resistive losses, may reduce the required electrical energy and the dissipated waste heat to manageable levels. The third technology is that of front glacis armor whose improvement now threatens to defeat present kinetic energy projectiles. It was the conclusion of the study that, at the present, the advantage of potentially greater muzzle velocity attainable from electromagnetic launchers does not outweigh the disadvantage of limited rate of fire.

1.7 Facility Location

- **Study Leader:** Jonathan Katz
- **Study Sponsor:** Agency
- **Report:** JSR-94-530 (S)

This study does not lend itself to an unclassified abstract.

1.8 FBI Liaison

- **Study Leader:** Dick Garwin
- **Study Sponsor:** FBI
- **Report:** JSR-94-360 (S)

JASON continued its support of FBI liaison efforts.

1.9 Hydrotesting

- **Study Leader:** Doug Eardley
- **Study Sponsor:** DOE
- **Report:** JSR-94-340 (U)

As part of the JASON study on Stewardship of nuclear weapons, a separate examination of the question of the utility, and need for, hydronuclear testing was undertaken. A *hydrotest* is an explosively driven implosion of simulated components of a nuclear primary, but without achieving criticality for nuclear chain reactions. A *hydronuclear* test is also an explosively driven implosion, with fissionable special nuclear materials now involved, such as plutonium or U^{235} , and a critical mass is achieved but with limited nuclear yield. In other words, it amounts to a carefully controlled fizzle of a real nuclear weapon through deliberate design or modification of a real weapon. Hydro, or hydronuclear, tests address the primary component of nuclear weapons. As with all activities concerning nuclear weapons, the current purpose of these tests is to assure the safety, reliability and performance in the stewardship of the US stockpile of nuclear weapons. The primary of a nuclear weapon functions through the sudden assembly of a critical mass of fissionable material by means of high explosive. In most modern weapons explosively driven hydrodynamic implosion is used. The purpose of hydrotests is to study this hydrodynamic implosion in detail. *Hydronuclear* tests furthermore study the beginnings of the nuclear chain reaction in the implisively assembled primary. An important question, and the one examined in the JASON study, is the relative importance of hydro vice *hydronuclear* testing in assuring the safety, reliability and performance of nuclear weapons in an era of a comprehensive test ban.

1.10 IR Phenomenology

- **Study Leader:** Gordon MacDonald
- **Study Sponsor:** Agency
- **Report:** JSR-94-520 (S)

The use of IR sensors for remote sensing is complicated by the variable cooling and heating of targets and the interactions of infrared radiation with the intervening atmosphere. JASON undertook a study of these phenomena and made specific recommendations with regard to system design, calibration and testing.

1.11 LOSAT Program

- **Study Leader:** Jeremiah Sullivan
- **Study Sponsor:** ARMY
- **Report:** JSR-94-630 (U)

The Line Of Sight Testing (LOSAT) Program is a program at the White Sands Missile Range (WSMR). This program requires highly accurate knowledge of the angles specifying the orientation and the rate of change of these angles at the moment the missile is free of its launch. JASON produced a letter report that contained a number of suggestions for obtaining this knowledge using existing test equipment at WSMR.

1.12 Low Observable Vehicles and Camouflage

- **Study Leader:** Jeremiah Sullivan
- **Study Sponsor:** Army
- **Report:** JSR-94-610 (U)

The Army would like to improve its ability to hide its vehicles and its ability to find those of the enemy. Our work in this area addressed three issues: (1) amorphous coatings for reducing radar and IR signatures; (2) application of foams to camouflage; and (3) use of multispectral data for vehicle detection. This and previous JASON work suggests that certain "designer" amorphous materials might be developed for use as vehicle coating for low radar return and simultaneously low IR emissivity. Such materials might consist of epoxy materials loaded with random, close packed spheres with coatings chosen to have specific dielectric and magnetic properties. Simple calculations suggests that foams might be an effective way of reducing thermal and visual signatures of parked vehicles and other battlefield hardware under certain circumstances. The JASON work in the use of multispectral techniques this year led to a better understanding of the physics behind the techniques being explored to discriminate targets from backgrounds.

1.13 Magnetic Effects

- **Study Leader:** Jeremy Goodman
- **Study Sponsor:** Navy
- **Report:** JSR-94-241 (S)

Recent openness in the former Soviet Union (FSU) has allowed access to personnel and systems that were of interest to the Navy. JASON examined the claims of Russian engineers for the operation and performance of a particular such system.

1.14 Mission to Planet Earth

- **Study Leader:** Steve Koonin, Tom Prince
- **Study Sponsor:** NASA
- **Report:** JSR-94-750 (U), JSR-94-751 (U)

JASON began an effort to provide to NASA recommendation concerning the evolution of the MTPE system that will allow inclusion of emerging technologies and still accomplish the scientific goals of the program. This summer JASON examined issues relating to (1) the balance between monitoring and studies of processes; (2) the adequacy of EOS Phase I to achieve its scientific goals; (3) issues for EOS Phase II; and (4) issues of calibration, validation and continuity.

1.15 Rapid Detection of CBW

- **Study Leader:** Nate Lewis
- **Study Sponsor:** ARMY
- **Report:** JSR-94-620 (U)

The Army is proposing to develop and field a system for detecting CBW agents on the battlefield. JASON reviewed this program during the summer study. JASON recommended that the Army consider the development of an alternate system of networked sensors that would be cheap and expendable.

1.16 Review of Audio Program

- **Study Leader:** Dick Garwin
- **Study Sponsor:** FBI
- **Report:** JSR-94-350 (U)

This study does not lend itself to an unclassified abstract.

1.17 SAR Change Detection

- **Study Leader:** John Vesecky
- **Study Sponsor:** Agency
- **Report:** JSR-94-510 (U), JSR-94-511 (S)

JASON undertook a study to examine the phenomenology and opportunities of using SAR imagery for change detection.

1.18 SAR Lite

- **Study Leader:** Al Despain
- **Study Sponsor:** ARPA
- **Report:** JSR-94-170 (U)

JASON undertook to develop a system concept for an inexpensive UAV that would be capable of satisfying the needs of commanders for real, or near real, time battlefield intelligence. The system concept takes advantage of novel processing and communications concepts to achieve reductions in weight and power that allow a significant reduction in cost. Based on the analysis of the study it appears that a SAR Lite system could be duplicated for about \$2M per copy (after the first 10). The SAR Lite system can only return about 5% of its images in real time - those images that are preselected and/or in which some change has occurred. The full set of images are stored on board and are recovered when the UAV returns. The report also continues with the development of exact algorithms for processing of SAR data.

1.19 Security and Privacy in the NII

- **Study Leader:** Peter Weinberger
- **Study Sponsor:** ARPA
- **Report:** JSR-94-150 (U)

The National Information Infrastructure (NII) is a vast undertaking to provide a web of networks, computers and databases to communication and information throughout the country. One of the more difficult topics is privacy and security on the NII. These are areas that are crucial to making the NII fully useful for government and for commerce. The JASON study examined technical issues of security and privacy and came to the conclusion that the problems are policy and not technical in nature. That is, the technology exists to provide security and privacy services on the NII but that issues of what services and their implementation must be resolved. The report suggests some steps that ARPA can make to help resolve the policy issues.

1.20 Science Based Stockpile Stewardship

- **Study Leader:** Sid Drell
- **Study Sponsor:** DOE
- **Report:** JSR-94-345 (U), JSR-94-346 (U)

The FY1994 National Defense Authorization Act calls on the Secretary of Energy to "establish a stewardship program to ensure the preservation of the core intellectual and technical competencies of the United States in nuclear weapons. The DOE asked JASON to review its Science Based Stockpile Stewardship program with respect to three criteria: 1) contributions to important scientific and technical understanding and to national goals; 2) contributions to maintaining and renewing the technical skill base and overall level of scientific competence in the defense program and the weapons labs, and to the broader U.S. scientific and engineering strength; and 3) contributions to maintaining U.S. confidence in our nuclear stockpile without nuclear testing through improved understanding of weapons physics and diagnostics. In this report JASON analyzes the DOE program and makes specific recommendations regarding it.

1.21 Subsurface Science

- **Study Leader:** Gordon MacDonald
- **Study Sponsor:** DOE
- **Report:** JSR-94-330 (U)

The Department of Energy in 1985 established the Subsurface Science Program. The primary purpose of this program is to assist DOE's efforts to clean up wastes that have been disposed of underground and that have moved from surface sites into the underground. The physics, chemistry and biology of the subsurface environment are not well known. In this report JASON reviews the program and discusses the major scientific issues. In particular, the issues of subsurface transport and adhesion of bacteria are examined. Also discussed in the report are alternatives to the use of borosilicate glasses for the disposal of high-level radioactive waste.

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